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DRAWINGS ATTACHED

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(54) IMPROVEMENTS IN AND RELATING TO CENTRIFUGAL COMPRESSORS

(71) We, DRESSER INDUSTRIES, INC., a corporation organised under the laws of the State of Delaware, United States of America, of Republic National Bank Building, Dallas, Texas 75221, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is concerned with improvements in and relating to centrifugal compressors.

In the design of compressors or compressor systems for supplying plant air, that is compressed air for the operation of air-powered tools for example, provision must be made for fluctuating demands which is characteristic of this type of load; and it is a characteristic of constant speed centrifugal compressors that they operate at peak efficiency for a relatively narrow range of volume flow. Surge or pulsation is an unstable operating condition of centrifugal compressors which occurs when the flow rate in the compressor has been reduced to some value below a designated operating point of the machine. Intensity of surge can be such that it produces violent shocks which may be damaging to the machine.

One approach for extending the range of volume flow at which a constant speed centrifugal compressor will operate at peak efficiency and for lowering the design flow rate point at which surge will occur is to provide a diffuser having a variable flow area which can be adjusted in accordance with the demanded flow rate through the compressor. It is known to provide vaneless diffusers wherein one wall of the diffuser passage is an annular member which may be moved relative to the opposite wall to vary the diffuser width.

According to the present invention there is provided a centrifugal compressor comprising a casing defining a compression chamber and an annular discharge chamber, an impeller in said compression chamber, an annular diffuser passage communicating between said compression chamber and said discharge chamber, one of the opposed walls of the diffuser passage including a part movable relative to the other wall to vary the axial dimension of said diffuser passage, said movable wall part comprising a ring member carried by a plurality of posts parallel to the impeller axis and engaging guide means on said casing for rectilinear movement parallel to the axis of said impeller, an annular control member mounted for rotation on said casing in axial alignment with said movable wall part and parallel thereto, said control member defining a plurality of cams each defined by opposed surfaces of said control member inclined along an arc relative to the plane of rotation of said control member, and means coupling each post to a control member cam whereby partial rotation of said control member in either direction relative to said casing will effect rectilinear movement of said posts relative to said casing and corresponding rectilinear movement of said movable diffuser wall part.

In order that the invention may be well understood there will now be described an embodiment thereof, given by way of example only, reference being had to the accompanying drawings in which:

Figure 1 is a sectional view of a centrifugal compressor in a plane through the impeller axis;

Figure 2 is a fragmentary view of the compressor along the line 2-2 of Figure 1; and

Figure 3 is a sectional view of a portion of the control assembly as viewed along the line 3-3 of Figure 2.

Referring to the drawings, there is shown a centrifugal compressor having a casing

defined by casing portions 10 and 11, secured together adjacent the outer peripheries by suitable bolts. The compressor casing defines a compression chamber between the inlet nozzle 12, in the casing portion 10, and the annular discharge cham-13, adjacent to the outer periphery of the casing. An impeller 14 having blades 15 is mounted for rotation within the compression chamber, being secured to a suitable shaft 16 which extends through an opening 17 in the casing portion 11. The opening 17 may accommodate suitable seal or bearing housings for the impeller shaft.

Surrounding the impeller 14 is a vaneless diffuser which is an annular radially directed passage 20 communicating the outer periphery of the impeller 14 and the discharge chamber 13. A fixed wall of the diffuser passage is defined by the casing portion 11; and a movable wall member 21 of the diffuser passage is defined by an annular member which is disposed in an annular groove 22 in the casing portion 10 concentric with the axis of rotation of the impeller. The movable wall member is generally rectangular in cross section, with the surface defining the diffuser wall surface being contoured for smooth air flow. Correspondingly, the annular groove 22 is generally rectangular in cross section, and is dimensioned to receive the movable wall member with a relatively close fit.

The movable wall member 21 is supported and guided for reciprocating axial movement on four cylindrical posts 23 which extend through cylindrical bores 24 in the casing portion 10, these bores being parallel to each other and being circumferentially equally spaced concentric with the impeller axis. The posts 23 are dimensioned for a close sliding fit within the respective bores 24; and the posts are provided with threaded studs 25 and 26 projecting from opposite ends thereof. The posts 23 are rigidly secured to the movable wall member 21 by the threaded engagement of the studs 25 in suitable threaded holes in the movable wall member.

In order to prevent circulation of gas around the movable wall member 21, that is radially through the groove 22, which may occur because of the pressure gradient which exists across the movable wall member during normal operation of the compressor, sealing devices are provided at the inner and outer peripheries of the wall member. An inner piston type seal ring 27 is disposed in a suitable annular groove in the inner cylindrical wall of the annular groove 22 to provide a seal between this cylindrical wall and the inner cylindrical wall of the wall member 21. An outer seal ring 28 is disposed in an annular groove in the outer cylindrical wall of the movable wall member 21 to provide a seal between this cylindrical wall and the outer cylindrical wall of the annular groove 22.

With these seals and the seals for the posts 23 to be described, there is created a trapped pocket or space between the movable wall member and the bottom of the annular groove 22. It is desirable to vent this trapped pocket; and this is accomplished by providing one or more vent passages 29 through the movable wall member. Preferably, these vent passages open to the diffuser side of the wall member at a precise radial location, again because of the pressure gradient across the movable wall member. The radial location is selected so that the pressure extant in the trapped pocket and acting on the movable wall member corresponds to the average pressure acting on the diffuser side of the movable wall member, that is that the forces acting on the opposite sides of the movable wall member are balanced so as not to effect the positioning of the movable wall member by the means to be described.

To prevent a leakage of gas from the trapped pocket to the exterior of the casing portion 10, O-ring seals are disposed in suitable annular grooves in the cylindrical walls of the posts 23 for sealing engagement with the walls of the bores 24.

From the foregoing it will be seen that the movable diffuser wall member 21 is mounted and guided for reciprocating axial movement relative to the fixed diffuser wall, is prevented from rotation relative to the casing, and is gas-tightly sealed in the casing.

The reciprocating movement of the movable diffuser wall member 21 is controlled by a control member 32, which is an annual ring mounted for rotation on the exterior of the casing portion 10 concentric with the impeller axis. The inlet nozzle 12 of the casing portion 10 defines an outer cylindrical surface within which is provided an external ball race 33; and the inner cylindrical surface of the control ring 32 is provided with a complementary ball race 34. With suitable balls 42, then, the control ring 32 is rotatably secured to the housing portion 10 and prevented from relative axial movement.

The control ring 32 provides angularly equally spaced helical cams 35 which are defined by inclined arcuate webs 36, the webs being divided radially by arcuate slots 37 concentric with the axis of rotation of the control ring.

The helical cams 35 are so related to the posts 23 that the post studs 26 extend through the respective slots 37. The opposite faces of the webs 36 are engaged by bearing members 38 in the form of wedge-shaped washers having bosses 39 which

extend into the slots 37, two of the members 38 being positioned over each of the respective threaded studs 26 and secured thereon by means of suitable nuts. These bearing members may be fabricated of a suitable bearing material such as Oilite bronze (the word "Oilite" being a Trade Mark), and function as followers of the helical cams. Each of the helical cams has the same relation to the plane of rotation of the control ring 32 so that as the control ring is partially rotated the movable diffuser wall member is positioned in selected parallel planes relative to the fixed diffuser wall.

A control arm 40 is suitably secured to the control ring 32, and this may be actuated by any suitable control mechanism to partially rotate the control ring in either direction in response to the operating conditions of the compressor, for example. The above described mechanism provides a very positive and precise control for varying the width of the diffuser passage 20.

WHAT WE CLAIM IS:—

1. A centrifugal compressor comprising a casing defining a compression chamber and an annular discharge chamber, an impeller in said compression chamber, an annular diffuser passage communicating between said compression chamber and said discharge chamber, one of the opposed walls of the diffuser passage including a part movable relative to the other wall to vary the axial dimension of said diffuser passage, said movable wall part comprising a ring member carried by a plurality of posts parallel to the impeller axis and engaging guide means on said casing for rectilinear movement parallel to the axis of said impeller, an annular control member mounted for rotation on said casing in axial alignment with said movable wall part and parallel thereto, said control member defining a plurality of cams each defined by opposed surfaces of said control member inclined along an arc relative to the plane of rotation of said control member, and means coupling each post to a control member cam whereby partial rotation of said control member in either direction relative to said casing will effect rectilinear movement of said posts relative to said casing and corresponding rectilinear movement of said movable diffuser wall part.

2. A centrifugal compressor as set forth in claim 1 wherein the guide means on the casing comprise a plurality of bores extending parallel to the axis of rotation of the impeller, said bores being dimensioned to receive said posts with a sliding fit for supporting and guiding said movable wall part.

3. A centrifugal compressor as set forth in claim 1 or claim 2 wherein said ring member is received by an annular groove in the casing having a generally rectangular cross section, the ring member being rectangular in cross section and dimensioned to be received within said annular groove with a relatively close fit, the ring member in its maximum flow position being fully received within the groove and presenting with the adjacent casing portion a smooth diffuser wall surface.

4. A centrifugal compressor as set forth in claim 3 including sliding seal rings between the cylindrical surfaces of said ring member and groove.

5. A centrifugal compressor as set forth in claim 3 or claim 4 including vent means through said ring member for venting the annular space between said ring member and the bottom of said annular groove, said vent means opening to the diffuser side of said ring member at a predetermined radial position, such that the forces acting on the opposite sides of the ring member are balanced.

6. A centrifugal compressor as set forth in any of the preceding claims wherein said control member is mounted on said housing by means of complementary ballraces formed respectively in a peripheral wall of an axially extending portion of said casing and an inner wall of said annular control member, said casing portion and control member being coupled together by means of balls disposed within said ballraces.

7. A centrifugal compressor as set forth in any of the preceding claims wherein said cams are helical cams defined by angularly spaced inclined web portions of said control member, each web portion has a uniform thickness and includes an arcuate slot concentric with the axis of rotation, said posts extending through said arcuate slots and having follower means engaging both of the oppositely directed surfaces of said web portions.

8. A centrifugal compressor as set forth in claim 7 wherein the webs are angularly spaced and each post includes an axially extending stud extending through an arcuate slot and carrying a pair of bearing members making sliding engagement with the opposite faces of the web defining that slot.

9. A centrifugal compressor substantially as herein described with reference to the accompanying drawings.

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEET 1

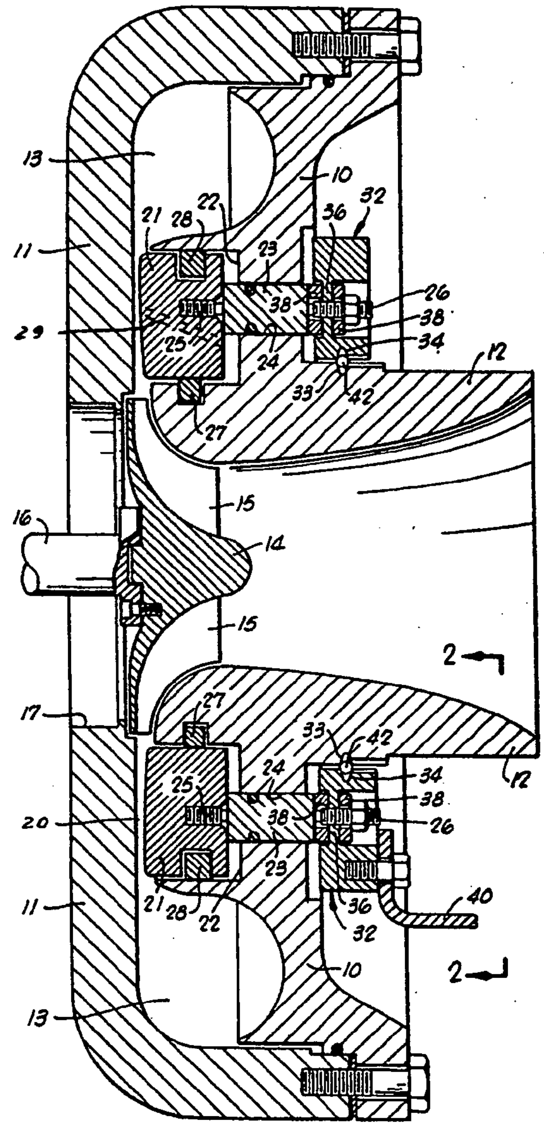

Fig-1

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1,231,152 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale.*
SHEET 2

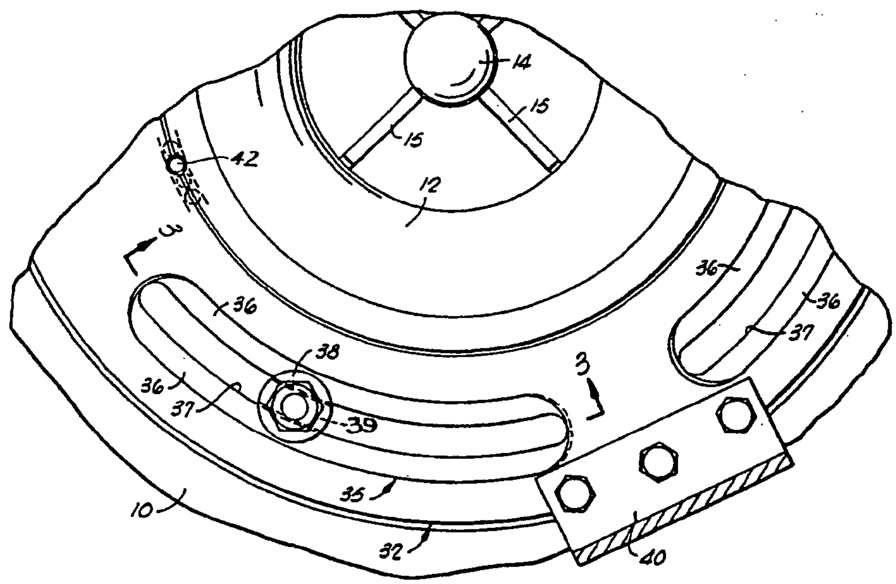

Fig-2

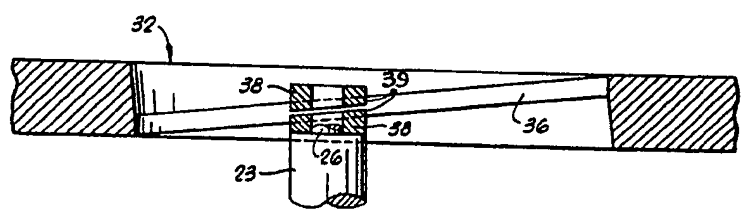

Fig-3